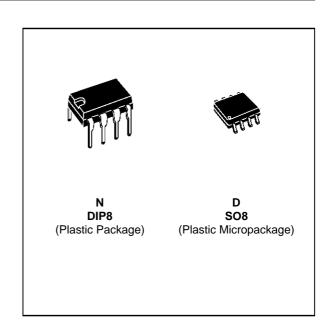


# **TS3V912**

# **3V** INPUT/OUTPUT **RAIL TO RAIL**DUAL CMOS OPERATIONAL AMPLIFIER

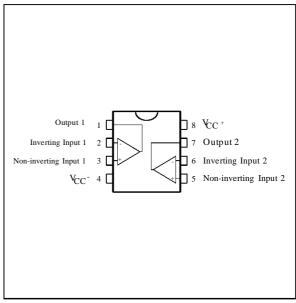
- DEDICATED TO 3.3V OR BATTERY SUPPLY (specified at 3V and 5V)
- RAIL TO RAIL INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE SUPPLY OPERATION FROM 2.7V TO 16V
- EXTREMELY LOW INPUT BIAS CURRENT : 1pA TYP
- LOW INPUT OFFSET VOLTAGE : 2mV max.
- SPECIFIED FOR **600**Ω AND **100**Ω LOADS
- LOW SUPPLY CURRENT : 200µA/Ampli (VCC = 3V)
- ESD TOLERANCE : 3KVLATCH-UP IMMUNITY



#### **ORDER CODES**

Part Number	Temperature Range	Pacl	kage
I alt Humber	remperature range	N	D
TS3V912I/AI/BI	-40, +125°C	•	•

# PIN CONNECTIONS (top view)



## **DESCRIPTION**

The TS3V912 is a RAIL TO RAIL dual CMOS operational amplifier designed to operate with a single 3V supply voltage.

The input voltage range  $V_{icm}$  includes the two supply rails  $V_{CC}^{-}$  and  $V_{CC}^{-}$ .

The output reaches:

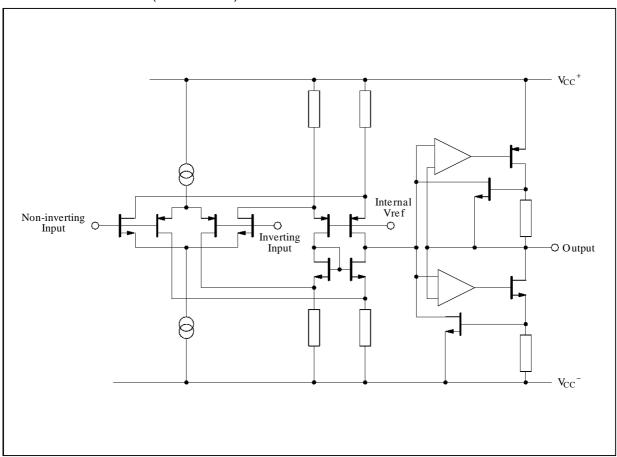
- $V_{CC}^{-}$  +50mV  $V_{CC}^{+}$  -50mV with  $R_L = 10k\Omega$
- $V_{CC}^- + 350 \text{mV}$   $V_{CC}^+ 350 \text{mV}$  with  $R_L = 600 \Omega$

This product offers a broad supply voltage operating range from 2.7V to 16V and a supply current of only  $200\mu\text{A/amp}$ . (V<sub>CC</sub> = 3V).

Source and sink output current capability is typically 40mA (at Vcc = 3V), fixed by an internal limitation circuit.

March 1996 1/9

# SCHEMATIC DIAGRAM (1/2 TS3V912)



### **ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
Vcc	Supply Voltage - (note 1)	18	V
V <sub>id</sub>	Differential Input Voltage - (note 2)	±18	V
Vi	Input Voltage - (note 3)	-0.3 to 18	V
l <sub>in</sub>	Current on Inputs	±50	mA
Io	Current on Outputs	±130	mA
T <sub>oper</sub>	Operating Free Air Temperature Range TS3V912I/AI/BI	-40 to +125	°C
T <sub>stg</sub>	Storage Temperature	-65 to +150	°C

Notes:

- All voltage values, except differential voltage are with respect to network ground terminal.
   Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
   The magnitude of input and output voltages must never exceed V<sub>CC</sub><sup>+</sup> +0.3V.

#### **OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
Vcc	Supply Voltage	2.7 to 16	٧
V <sub>icm</sub>	Common Mode Input Voltage Range	V <sub>CC</sub> <sup>-</sup> -0.2 to V <sub>CC</sub> <sup>+</sup> +0.2	V



# **ELECTRICAL CHARACTERISTICS**

 $V_{CC}^+ = 3V$ ,  $V_{CC}^- = 0V$ ,  $R_L$ ,  $C_L$  connected to  $V_{CC}/2$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter			TS3V912I/AI/BI			
Symbol	Parameter	Min.	Тур.	Max.	Unit		
Vio	Input Offset Voltage ( $V_{ic} = V_o = V_{CC}/2$ ) $T_{min.} \le T_{amb} \le T_{max.}$	TS3V912 TS3V912A TS3V912B TS3V912 TS3V912A TS3V912B			10 5 2 12 7 3	mV	
DVio	Input Offset Voltage Drift			5		μV/°C	
I <sub>io</sub>	Input Offset Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$			1	100 200	pA	
l <sub>ib</sub>	Input Bias Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$			1	150 300	pA	
I <sub>CC</sub>	Supply Current (per amplifier, $A_{VCL} = 1$ , no $I_{min.} \le T_{amb} \le T_{max.}$	oad)		200	300 400	μΑ	
CMR	Common Mode Rejection Ratio	$V_{ic} = 0 \text{ to } 3V, V_o = 1.5V$	50	80		dB	
SVR	Supply Voltage Rejection Ratio (V <sub>CC</sub> <sup>+</sup> = 2.7	to 3.3V, $V_O = V_{CC}/2$ )	50	80		dB	
A <sub>vd</sub>	Large Signal Voltage Gain ( $R_L = 10k\Omega$ , $V_O = T_{min.} \le T_{amb} \le T_{max.}$	= 1.2V to 1.8V)	3 3	10		V/mV	
V <sub>OH</sub>	High Level Output Voltage (V <sub>id</sub> = 1V)	$\begin{aligned} R_L &= 100 k \Omega \\ R_L &= 10 k \Omega \\ R_L &= 600 \Omega \\ R_L &= 100 \Omega \end{aligned}$	2.95 2.9 2.3	2.96 2.6 2		V	
	$T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$	2.8 2.1				
V <sub>OL</sub>	Low Level Output Voltage ( $V_{id} = -1V$ )	$\begin{array}{l} R_L = 100 k\Omega \\ R_L = 10 k\Omega \\ R_L = 600\Omega \\ R_L = 100\Omega \end{array}$		30 300 900	50 70 400	mV	
	$T_{min.} \le T_{amb} \le T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$			100 600		
Io	Output Short Circuit Current ( $V_{id} = \pm 1V$ )	Source $(V_o = V_{CC}^-)$ Sink $(V_o = V_{CC}^+)$	20 20	40 40		mA	
GBP	Gain Bandwidth Product $(A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 10k\Omega)$	0kHz)		0.8		MHz	
SR⁺	Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100p$	F, $V_i = 1.3V$ to 1.7V)		0.3		V/μs	
SR <sup>-</sup>	Slew Rate (A <sub>VCL</sub> = 1, R <sub>L</sub> = $10k\Omega$ , C <sub>L</sub> = $100pF$ , V <sub>i</sub> = $1.3V$ to $1.7V$ )			0.4		V/μs	
Øm	Phase Margin			30		Degrees	
en	Equivalent Input Noise Voltage ( $R_s = 100\Omega$ ,	f = 1kHz)		30		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$	
V <sub>O1</sub> /V <sub>O2</sub>	Channel Separation (f = 1kHz)			120		dB	

Note 1: Maximum values including unavoidable inaccuracies of the industrial test.

# **ELECTRICAL CHARACTERISTICS**

 $V_{CC}^+ = 5V$ ,  $V_{CC}^- = 0V$ ,  $R_L$ ,  $C_L$  connected to  $V_{CC}/2$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter			TS3V912I/AI/BI			
Syllibol	Parameter	Min.	Тур.	Max.	Unit		
Vio	Input Offset Voltage ( $V_{ic} = V_o = V_{CC}/2$ ) $T_{min.} \le T_{amb} \le T_{max.}$	TS3V912 TS3V912A TS3V912B TS3V912 TS3V912A TS3V912B			10 5 2 12 7 3	mV	
DVio	Input Offset Voltage Drift			5		μV/°C	
I <sub>io</sub>	$\begin{array}{c} \text{Input Offset Current - (note 1)} \\ T_{\text{min.}} \leq T_{\text{amb}} \leq T_{\text{max.}} \end{array}$			1	100 200	pA	
l <sub>ib</sub>	Input Bias Current - (note 1) $T_{min.} \le T_{amb} \le T_{max.}$			1	150 300	pA	
Icc	Supply Current (per amplifier, $A_{VCL} = 1$ , no $T_{min.} \le T_{amb} \le T_{max.}$	load)		230	350 450	μΑ	
CMR	Common Mode Rejection Ratio $V_{ic} = 1.5$ to 3.5V, $V_0 = 2.5$ V		60	85		dB	
SVR	Supply Voltage Rejection Ratio (V <sub>CC</sub> <sup>+</sup> = 3 t	o 5V, V <sub>O</sub> = V <sub>CC</sub> /2)	55	80		dB	
A <sub>vd</sub>	Large Signal Voltage Gain ( $R_L = 10k\Omega$ , $V_O$ $T_{min.} \le T_{amb} \le T_{max.}$	= 1.5V to 3.5V)	10 7	50		V/mV	
V <sub>OH</sub>	High Level Output Voltage (V <sub>id</sub> = 1V)	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$	4.95 4.9 4.25	4.95 4.55 3.7		V	
	$T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$	4.8 4.1				
V <sub>OL</sub>	Low Level Output Voltage (V <sub>id</sub> = -1V)	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$		40 350 1400	50 100 500	mV	
	$T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$			150 750		
Io	Output Short Circuit Current (V <sub>id</sub> = ±1V)	Source $(V_0 = V_{CC}^-)$ Sink $(V_0 = V_{CC}^+)$	45 45	65 65		mA	
GBP	Gain Bandwidth Product $(A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 10k\Omega)$	00kHz)		1		MHz	
SR <sup>+</sup>	Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1V$ to $4V$ )			0.8		V/µs	
SR <sup>-</sup>	Slew Rate (A <sub>VCL</sub> = 1, R <sub>L</sub> = $10k\Omega$ , C <sub>L</sub> = $100$	pF, V <sub>i</sub> = 1V to 4V)		0.6		V/μs	
en	Equivalent Input Noise Voltage ( $R_s = 100\Omega$	2, f = 1kHz)		30		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$	
V <sub>O1</sub> /V <sub>O2</sub>	Channel Separation (f = 1kHz)			120		dB	
Øm	Phase Margin			30		Degrees	

Note 1: Maximum values including unavoidable inaccuracies of the industrial test.

#### **TYPICAL CHARACTERISTICS**

Figure 1: Supply Current (each amplifier) versus Supply Voltage

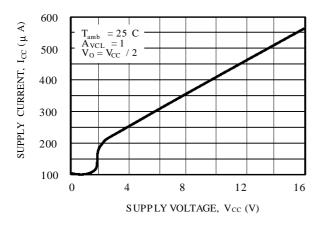


Figure 3a: High Level Output Voltage versus High Level Output Current

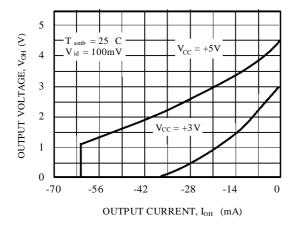


Figure 4a: Low Level Output Voltage versus Low Level Output Current

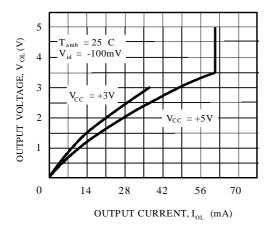


Figure 2: Input Bias Current versus Temperature

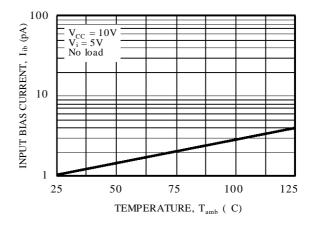


Figure 3b : High Level Output Voltage versus High Level Output Current

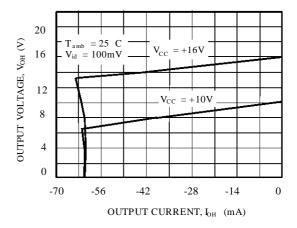


Figure 4b : Low Level Output Voltage versus Low Level Output Current

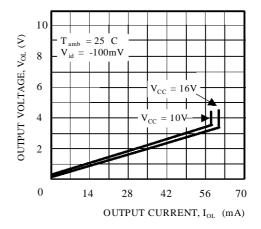
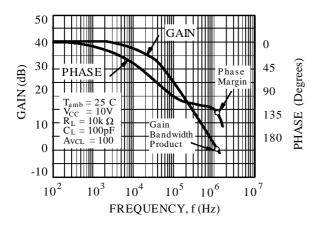


Figure 5a: Open Loop Frequency Response and Phase Shift



**Figure 6a :** Gain Bandwidth Product versus Supply Voltage

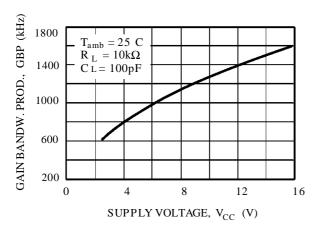


Figure 7a: Phase Margin versus Supply Voltage

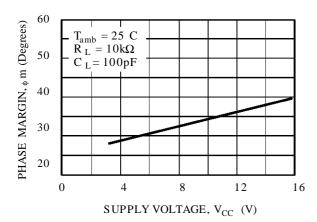
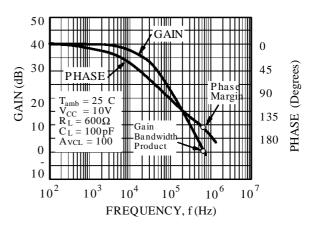


Figure 5b : Open Loop Frequency Response and Phase Shift



**Figure 6b**: Gain bandwidth Product versus Supply Voltage

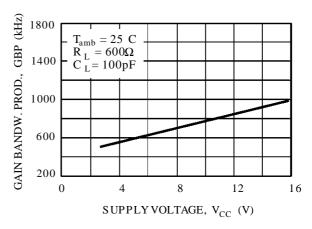
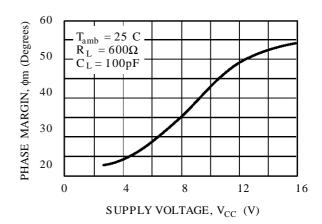


Figure 7b: Phase Margin versus Supply Voltage



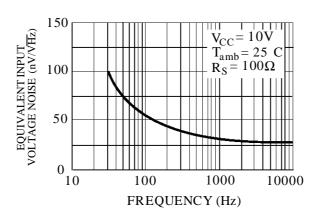
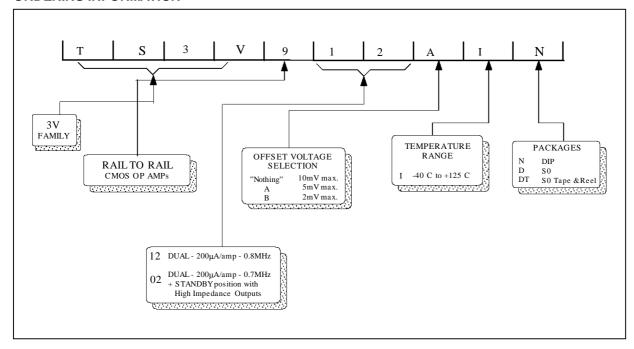


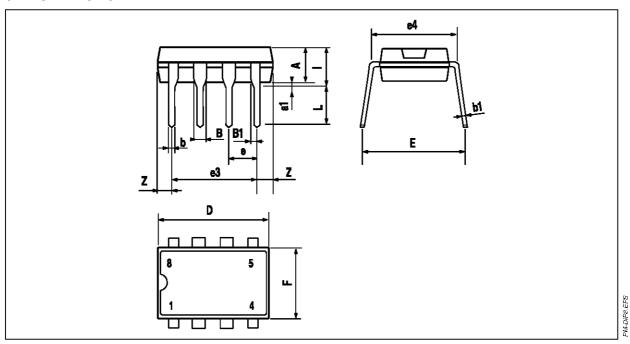
Figure 8: Input Voltage Noise versus Frequency

#### **ORDERING INFORMATION**



# **PACKAGE MECHANICAL DATA**

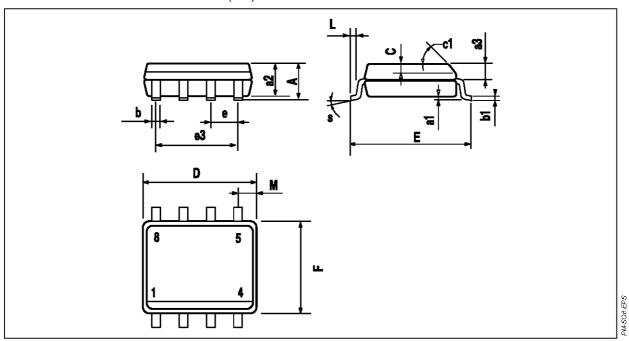
8 PINS - PLASTIC DIP



Millimeters					
Min.	Тур.	Max.	Min.	Тур.	Max.
	3.32			0.131	
0.51			0.020		
1.15		1.65	0.045		0.065
0.356		0.55	0.014		0.022
0.204		0.304	0.008		0.012
		10.92			0.430
7.95		9.75	0.313		0.384
	2.54			0.100	
	7.62			0.300	
	7.62			0.300	
		6.6			0260
		5.08			0.200
3.18		3.81	0.125		0.150
		1.52			0.060
	0.51 1.15 0.356 0.204 7.95	Min. Typ. 3.32  0.51 1.15 0.356 0.204  7.95  2.54 7.62 7.62	Min.         Typ.         Max.           3.32         3.32           0.51         1.65           1.15         1.65           0.356         0.55           0.204         0.304           10.92         9.75           2.54         7.62           7.62         6.6           5.08         3.18           3.18         3.81	Min.         Typ.         Max.         Min.           3.32         0.020           1.15         1.65         0.045           0.356         0.55         0.014           0.204         0.304         0.008           10.92         0.313           2.54         7.62           7.62         6.6           5.08         3.18           3.18         3.81         0.125	Min.         Typ.         Max.         Min.         Typ.           3.32         0.131         0.020         0.131           0.51         0.020         0.045         0.045           0.356         0.55         0.014         0.008           0.204         0.304         0.008         0.008           7.95         9.75         0.313         0.100           7.62         0.300         0.300           7.62         0.300         0.300           3.18         3.81         0.125

#### **PACKAGE MECHANICAL DATA**

8 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions		Millimeters			Inches	
Dimensions	Min.	Тур.	Max.	Min.	Тур.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
С	0.25		0.5	0.010		0.020
c1		•	45°	(typ.)	•	
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
е		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
М			0.6			0.024
S			8° (	max.)		-

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